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COLOUR TELEVISION: LATEST POSITION WITH REGARD TO THE SECAM SYSTEM

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RESEARCH DEPARTMENT

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The writers visited the Compagnie Française de Télévision (C.F.T.) near Paris on Monday, 16th April 1962, to attend demonstrations of the effectiveness of the latest modifications to the SECAM system.

1. DESCRIPTION OF MODIFICATIONS

It will be remembered that the method of modulation of the chrominance subcarrier had been altered from amplitude modulation to frequency modulation some time ago but the major fault of the system at that time was lack of compatibility in comparison with that of the NTSC system. The purpose of the change from a.m. to f.m. was, of course, to increase the ruggedness of the chrominance signal in so far as noise during fringe-area reception was concerned and this, the frequency modulation succeeded in doing to such an extent that there was no difference in fringe-area performance between the two colour systems (NTSC and SECAM). The chrominance signal, however, remained more easily visible during black-and-white reception of the SECAM signal than in the case of NTSC.

The C.F.T. have evidently tried very hard to achieve compatibility equal to that of the NTSC system and the methods that they have adopted are as follows:

(i) Pre- and de-emphasis of the chrominance video signals (R - Y, B - Y). We did not learn the value of the time constant used but the shapes of the curves conform to simple pre- and de-emphasis.

(ii) Reduction of the peak frequency deviation to 350 kc/s in a chrominance bandwidth of ± 500 kc/s at the -3 dB points. This reduction reduces very considerably the curious patterns, termed "ladders" by the C.F.T. engineers, which result from excessive frequency deviation. This gives rise to a spectrum requiring for its distortionless transmission a bandwidth considerably wider than that allowed for in the chrominance channel of the SECAM receiver.

(iii) Reduction in the amplitude of the chrominance carrier to 20% of picture signal magnitude.

(iv) Radio frequency pre- and de-emphasis such that the transmitted chrominance signal is boosted by about 6 dB when it is deviated to either ± 300 kc/s from its central (white) value of 4·43 Mc/s. The purpose of this r.f. pre-emphasis is to increase the amplitude of the chrominance carrier when the more saturated colours are being transmitted and thus to compensate for the de-emphasis in the receiver and maintain a reasonable signal-to-noise ratio in these conditions. The advantage of radio-frequency chrominance-channel de-emphasis in the colour receiver in reducing the effective noise and interference bandwidth of the latter is self-evident. A disadvantage of the use of r.f. pre- and de-emphasis in the chrominance channel is that, although every other line of each field of a uniformly coloured scene will be transmitted at constant chrominance-signal amplitude, adjacent lines of each field will usually give rise to chrominance signals of different amplitudes. Consider, for example, a uniformly illuminated and coloured scene (that is, a plain coloured background) in which the colour happens to be that described by a certain value for R - Y and a null value for B - Y. Without r.f. pre-emphasis, the transmitted chrominance signal would have had a constant amplitude whether it were transmitting R - Y = constant or B - Y = 0; but due to the r.f. pre-emphasis causing an increase in amplitude of the R - Y signal each line which is designated to transmit R - Y will have a higher amplitude than each line designated to transmit B - Y. This inequality in chrominance signal amplitude between adjacent lines in each field tends to reduce the compatibility of the SECAM signal because it doubles the pitch of the interfering dot pattern on monochrome receivers. The C.F.T. engineers are now planning to introduce further amplitude modulation (over and above that caused by the r.f. pre-emphasis) of such a type that the weaker of the two chrominance signals will always be increased until equality of amplitude is attained. Of course the colour receiver will have to have an appropriate demodulating circuit in order to compensate. This extra amplitude modulation will tend to reduce compatibility from what it would have been if both the colour-difference signals had been transmitted at the lower, that is the non-r.f. pre-emphasized value, but it is thought that the reduction in compatibility mentioned will be insignificant. We did not see this further amplitude modulation but it would certainly be necessary to use it if 100% saturated colour bars at 75% amplitude were representative of a statistically significant number of pictures because the double-pitch interference pattern on monochrome receivers was visible during the transmission of such colour bars but not during the transmission of slides and film.

2. NOTES ON SUBJECTIVE TESTS

The demonstrations used closed-circuit video systems (NTSC and SECAM) and our conclusions could be modified to a certain extent by radio-frequency field trials. The standard used as a basis for the tests was the 625-line 50-field 5 Mc/s-video system. All the subjective tests were undertaken at a viewing distance of four times picture height, except where otherwise stated.

2.1. Compatibility

The 21 in (53 cm) monitor used for viewing black-and-white compatible pictures had an attenuation of about -3 dB at 4·43 Mc/s, the undeviated colour subcarrier frequency. The threshold viewing distances for the interfering dot pattern due to the chrominance signal were

NTSC	8 ft (2·4 m)
SECAM	7½ ft (2·3 m)

during the transmission of a reasonably saturated colour slide. Using the same slide and rating the interference on the usual six-point scale* we rated the dot pattern on NTSC as 2·8 and the dot pattern on SECAM as 2·5. When 100% colour bars at 75% saturation were transmitted it was found that the NTSC system was much better than the SECAM but, as mentioned in Section 1(iv), this was due to the double-pitch interference pattern on SECAM. It may be assumed that the introduction of the further amplitude modulation will achieve equality once again between the two systems. In order to try to fix our ideas we asked for the ski-girl slide and the dot pattern ratings for this slide were NTSC 2·5 and SECAM 2. We then saw a couple of colour films and our ratings for the dot pattern visibilities on the monochrome screen were NTSC 2 and SECAM 2·5. It will be noted that for the film the SECAM system was less good than NTSC, whereas for slides the reverse was the case. We think that this was due partly to the fact that moving pictures seemed to show up the SECAM dots rather more than they did the NTSC dots and the SECAM dots were, as is well known, present over the whole screen including those areas representing desaturated or even uncoloured patches in the original scene.

2.2. Colour

When we first saw the colour pictures they were poor in that the lack of sharpness in them was most noticeable. However, after some three quarters of an hour of adjustment and re-alignment a NTSC and a SECAM colour picture of quite good quality were achieved. There remained, nevertheless, an unfortunate difference between the two pictures, a difference which mitigated in favour of the NTSC colour picture. The C.F.T. engineers had a horizontal aperture corrector in the luminance channel of the NTSC network but not in that of the SECAM signal, with the result that the NTSC pictures were slightly sharper than those from the SECAM system. We therefore asked our hosts to operate the NTSC system without the aperture corrector so that we had equivalent luminance sharpnesses to view. There then remained very little difference between the two colour pictures. Two points, however, should be made; one is that the dot pattern on edges, produced on this particular NTSC colour receiver, was a good deal more visible than the dot pattern on the SECAM colour screen. Here again some changes were made in order to assist us to form a judgement. The SECAM colour receiver had in it a notch filter which they told us was about 12 dB deep and -3 dB at ± 300 kc/s and this was, we felt, more than adequate to remove the dot structure from the SECAM colour picture. We also mentioned the fact that we had understood that a notch filter is not necessary in a SECAM colour receiver because the chrominance signal amplitude is nominally constant (due to the use of f.m.) and that therefore the luminance due to the dot structure on the SECAM colour screen can be eliminated by "sitting the picture down" by a suitable amount. We were reminded

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*1. Imperceptible.
2. Just perceptible.
3. Definitely perceptible but not disturbing.
4. Somewhat objectionable.
5. Definitely objectionable.
6. Unusable.

that the amplitude of the SECAM chrominance signal is now no longer constant because of the use of r.f. pre-emphasis; nevertheless, at our request, the notch filter was removed and the dot structure then became just visible, although at a viewing distance of four times picture height it was a good deal less visible than the dot pattern on edges in the NTSC colour picture. The elimination of the notch filter in the SECAM receiver seemed to us to be worthwhile and the increase of luminance due to the presence of the dot structure, which should have desaturated the picture to a certain extent, did not appear to do so. This is a statement of subjective fact but an explanation for it is not known.

One of the slides used in these tests depicted a woman holding a basket of washing near a clothes-line and the lady was wearing a blouse containing blue and red vertical stripes of various widths and, because one of her arms was bent at the elbow, these stripes changed more or less gradually from the vertical to the horizontal thus rendering the slide an extremely useful one from a colour reproduction point of view. The C.F.T. engineers told us that they had obtained the slide from the same American source as other "NTSC" slides. Some of the red lines in the blouse were too narrow for a narrow-band colour-difference transmission to resolve and whether a wide-band I NTSC system would have resolved them is a moot point. We knew the correct colours because our hosts had supplied a full-bandwidth R, G, B colour picture for comparison purposes. In resolving these thin red vertical lines each system distorted the red colour in a different manner but, as neither gave the correct rendition, it appears reasonable to rate the two systems as equal, at least in so far as horizontal colour resolution is concerned. The NTSC picture, however, did give some indication that the red line in the blouse was red on the woman's nearly horizontal forearm, whereas the SECAM system was not able to do this. In fact, this test was an interesting demonstration of the equal horizontal and vertical colour resolution supplied by the SECAM system and the unequal resolution offered by the NTSC system. It should perhaps be added that, although with the particular receivers being used the NTSC and SECAM systems offer approximately the same horizontal resolution, the NTSC system does offer twice the vertical resolution. The scientific integrity of the C.F.T. engineers should here be mentioned because they need not have shown us this "washing-woman" slide.

We checked that with all the recent modifications which have been made to the SECAM system the fringe-area reception was the same with regard to noise as in the case of the NTSC system. For this test the signal level was reduced until very noisy pictures were obtained on the two colour monitors. The threshold viewing distances for the noise on the two screens were then examined and they were found to be equal to one another, the figure being 21 ft (6·4 m).

3. CONCLUSIONS

3.1. Compatibility

With regard to dot pattern visibility the SECAM system is better on still pictures and worse on film than the NTSC system but in either case it is quite satisfactory on 625-line pictures.

3.2. Colour

The two systems are virtually indistinguishable, except that for the first time we have seen a slight loss in vertical colour resolution, which theory would indicate the SECAM system to possess. The NTSC system has more flexibility with regard to colour resolution in that by employing the orange-cyan transformation, the chrominance information is capable of resolving horizontal colour detail three times as fine as that of the SECAM system. It is true that present-day commercial receivers do not take advantage of the orange-cyan transformation, but better quality receivers of the future may do so.

We think that it is now time to subject the SECAM system to some field trials in order to make final comparisons between it and the NTSC system. If the field trials resulted in the two systems being as closely comparable as they appear to be from these restricted and preliminary inspections of the video performance, we should then be in a position to accept as an international standard whichever system found favour with other countries at international gatherings such as the C.C.I.R.

As the result of our visit, Monsieur Peyroles of the C.F.T. offered to lend to the B.B.C. the coder and de-coder together with six SECAM receivers so that we could make a comprehensive series of tests of the system. He agreed that this offer would be confirmed in writing and that he expected that delivery of the equipment would take place in June of this year. We were glad to accept this handsome offer.

BRH